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IN THREE SECTIONS

Section I

N.A.C.A. LIBRARY

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EDITORIAL DEPARTMENT NOTE

In this issue of our Bulletin we are presenting to our members two papers dealing with methods of wage payment. The chief purpose in submitting these papers is to illustrate the procedure followed in two well-known plants in making time and motion studies. In the first paper the purpose of the study was to determine standards to be used in establishing a gain-sharing method of wage payment, while in the second paper the piece rate method of wage payment is discussed.

Mr. R. E. Jacke, the author of the first paper, has been engaged in cost accounting work at the Reynolds Metals Company, formerly the United States Foil Company, for more than nine years. For the past two years he has been in charge of bonus installations in his company. Mr. Jacke has been secretary of our Louisville chapter for the past five years. His paper was awarded second prize in a contest conducted by the Louisville chapter during the year 1931-1932.

Mr. Claude O. Rainey, the author of the second paper, was graduated from Lockyear's Business Institute and from LaSalle Extension University in Higher Accounting and Banking. Prior to 1920 he spent some time with the J. W. Cockrum Printing Company and with the Bosse Coal Company. From 1920 to 1924 he was cost accountant for the Youngstown Pressed Steel Company, and from 1924 to the present time he has been associated with the Trico Products Company of Buffalo, New York, where he is now Chief Accountant. He has been active in the operation of our Buffalo chapter since 1926 and served as its president during the year 1931-32.

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September 15, 1932

SIMPLE APPLICATION OF GAIN-SHARING PRINCIPLES

By R. E. Jacke
Reynolds Metals Company, Louisville, Ky.

IN THE writer's opinion, to establish standards only as a means of control is like wearing only one shoe when a pair is available. A prominent speaker on the subject was asked by the writer if a gain-sharing plan would not produce better results than one designed only to control with standards. He was told that this was no advantage over adequate supervision. The speaker did not, however, explain what was meant by adequate supervision, which was the same as saying that an automatic operation has no advantage over a hand operation except that it is cheaper, more dependable and produces better results. It is a human attribute to resent force, but through fear for a livelihood the worker is beaten into submission rather than encouraged by the thought of personal gain which, to him, would seem tasty and pungent.

This paper is intended to describe a simple plan, installed without the aid of experienced men, which has operated very effectively and with better results than anticipated. This remark is not made for the purpose of discouraging the use of professional service but to encourage attempts of this kind as a means of greater operating efficiency instead of resorting to measures of wage cutting or compulsory standard control.

This plan was started with only a vague idea of what was wanted or how it could be applied. The handicap of too much system or detail did not exist and consequently a system was built around the actual conditions rather than the reverse, as it is often unsuccessfully attempted. The organization was not a perfect machine, as is usually assumed by many authorities, but an average operating business with all the peculiarities and adverse conditions of any business. The whole problem and solution was comparable to a shoemaker fitting a foot.

Here is how it was done. It was assumed that it would be a considerable advantage to place in charge of this undertaking someone from the Cost Department who was familiar with the factory operations, products, and accounting records. The choice

was also determined by certain qualifications such as technical knowledge based upon education, familiarity with up-to-date publications on the subject, and affiliation with the National Association of Cost Accountants.

The Plan

The adopted plan was to establish time standards for the various products, based upon operations at or below the present cost, depending upon the degree of present efficiency, and pay a group bonus equivalent to half of the time saved. This was not to be generally announced until the first department had been studied and standards established and checked, which will be described next under "Setting the Standard."

The operation of the plan consists of applying time standards, in terms of man hours per 100 pounds or 1000 pounds—according to the production unit—against the production of the department to determine total time allowed. From this time is deducted the actual time taken, or payroll hours, and the difference is the total time saved. Half of this difference is divided by the payroll hours and the percentage obtained represents bonus payable which is applied against the weekly payroll.

Form 1 is the Bonus Record used, illustrating the computation.

After standards for the first department were established, a set of simple rules was formed and sent, with a letter explaining the operation of the plan, to each operating department for the purpose of creating more interest and a greater desire for the installation.

Here is a list of the original rules that have served well without revision.

Rules Governing Bonus—(Subject to revision)

1. Time rates on production are guaranteed against change until December 31st of each year, at which time they are subject to change without notice. Also, at any time that a major mechanical change in processing is made, the company reserves the right to change bonus rates.
2. The bonus will be paid weekly.
3. The percentage paid will be half of the saving below the standard set.

Bonus Record Illustrating Calculations.

Department Paper Waxing — Week Ending March 26, 1932.

Day	Stock	Record of Production: Total		Reject	Net	Standard Time: Rate	Allow'd.	Total	Payroll Hours		Hours Saved	Bonus Hours	% Bonus Earned	Accum. Bonus	Remarks
38"	15-19 Tissue	17000		2000	15000	.41	61.50								
24"	25-31 Bond				10000	.44	44.00								
42"	35-45 Manila				20000	.13	26.00								
Mon. Totals Accum.								131.50	128.00		3.50	1.75	1.37%		
40"	15-19 Tissue				10000	.39	39.00								
20"	25-31 Bond				18000	.42	77.00								
38"	35-45 Manila	31000		1000	30000	.14	42.00								
Tues. Totals								169.00	135.00		24.00	12.00	8.87%		
Accum.								290.50	263.00					5.23%	

4. The bonus will be calculated on good production only—rejected material and unnecessary scrap will be charged back to the department or departments responsible. In the event that more than one department is responsible for this scrap, it will be divided among the departments at fault.
5. In the event that a man is transferred from one department to another, either permanently or temporarily, he will receive the bonus rate for the department in which he works.
6. Absence from work without just and real cause excludes employee from any bonus that week. In the event of actual sickness, or for some real reason, employee will not be penalized. However, in such instance, it will be necessary to secure the approval of the man in charge of the bonus.
7. Bonus will not be paid to straight-time men, absent due to personal cause, where a substitute is required; neither is their time charged against the department during this absence.
8. Discharge due to misconduct voids claim to any bonus unpaid.
9. Claims or recommendations should be stated clearly, in writing, by the department foreman, to the man in charge of the bonus.

BONUS RECORD

DEPT. _____ NO. _____

	PRODUCTION BONUS		SCRAP BONUS
	DAILY	ACCUM.	ACCUM.
MON.			
TUES.			
WED.			
THUR.			
FRI.			
SAT.			

TOTAL ACCUMULATED BONUS FOR WEEK _____

FORM 2

COST DEPARTMENT

Form No. 260a 5,27,31 1500

TIME STUDY

Dept. _____ Date _____ A. M. P. M. STUDY BY _____

WORK STATION _____ MACHINE CAPACITY _____

Product _____ Operators _____

Reading	Net	Reading	Net	Reading	Net	Reading	Net	Reading	Net	Reading	Net	Reading	Net	Reading	Net	Reading	Net

FORM 3
105

Another feature of the plan, which has proved worth while by results, is that the foremen and indirect men are included. This offers an automatic control of indirect time—such as trucking and helping—which is kept in definite ratio to operating time as will be explained later.

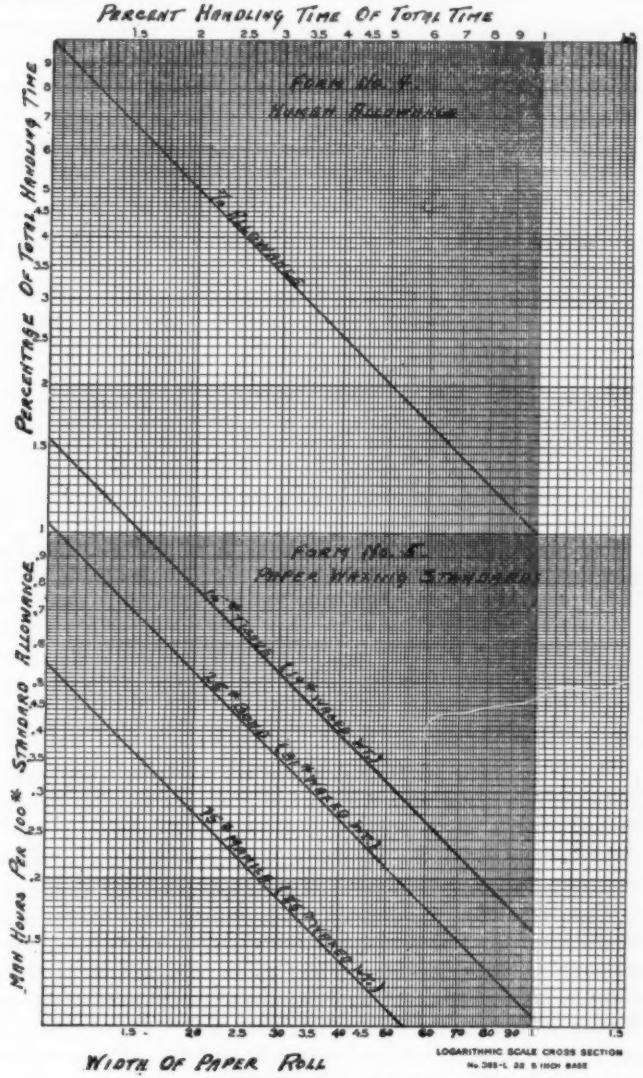
The bonus is posted daily on a blackboard placed conspicuously in each department for this particular purpose. Form 2 illustrates the type used.

Setting the Standard

To establish accurate standards without the advantage of previous experience was the most necessary and difficult part of the plan. This required practice on the continuous method of time studies before the information could be used with any assurance of accuracy. The decimal stop-watch of 1/100 minute units was selected. The study sheet was made simple in design, consisting of a form on the front to be used horizontally, for time study, and a plain ruled form on the back to be used vertically, sometimes to make particular studies suited to this type but mainly for assembling information and calculating standards. The study sheet is illustrated by Form 3.

The time study of the first department was preceded by a thorough survey of the whole plant for the purpose of gathering general information regarding operations, production, manufacturing routine, records, rules and general allowances. The factory practices were found to be fairly uniform and reasonably consistent in personal needs, department clean-up, morning and noon start-up, and evening shutdown. The factor of "Human Allowances" was established for all departments from these elements, as follows:

Elements	*Minutes Per Day*
Morning and noon start-up.....	6.00
Noon and end of day shutdown.....	4.00
Daily clean-up	10.00
Weekly clean-up 37.00	6.00
Daily toilet	20.00
Drinks	4.00
Daily allowance per man.....	50.00


PERCENT HANDLING TIME OF TOTAL TIME
PERCENTAGE OF TOTAL HANDLING TIME
FORM NO. 4.
HUMAN ALLOWANCE
FORM NO. 5.
PAPER WEARING STRENGTH
MAN HOURS PER 100 # STANDARD ALLOWANCE
WIDTH OF PAPER ROLL
LOGARITHMIC SCALE CROSS SECTION

FORMS 4 AND 5

Calculation:

Normal day ..	9.00 hours =540.00 minutes 50.00	
Percentage ...	540.00—50.00=10.2	Allowance on 100% Handling Time.

Form 4 shows the chart of "Human Allowance" percentages to be added to handling time according to the relation of handling to total time consumed on an operation.

The departments were taken in operation sequence, which was very helpful in determining operation cycles and stock conditions as the studies progressed. For example, suppose a familiar operation like rotary cutting were attempted before operations producing the various stocks were studied. This would require much time and effort to determine the standard length of stock received on reels, the cutting of which means a complete handling process. It is obvious that as the length varies the time per 1000 feet would also vary.

The procedure of setting standards falls into five divisions, namely:

1. Preparation
2. Time Studies
3. Study Analysis
4. Composition
5. Check-up.

The preparation involves gathering all the important information available concerning the operation before starting the time study. First, a study of the payroll for twelve months should be sufficient to establish the normal working payroll. It may also be necessary to get preliminary information from the department foreman regarding the division of payroll in order that it might be definitely checked during the time study. The payroll shows the trend of operation from which a few normal months are selected for the purpose of applying the standard against the production. Second, the production of normal months is recorded for the purpose of making a complete analysis of the production of operation to be studied. This will be especially valuable in de-

termining stock classifications for the time standard, as well as furnishing the basis for the marginal allowance, which never exceeds previous performance and many times leaves a cost saving that was not expected before the standard is equalled. In other words, this is the means of measuring the efficiency of past performance. Third is the prelude to the time study, the preliminary operation survey or investigation, the purpose of which is to analyze the operation into its various common elements.

The time study requires sufficient recordings of an operation to ascertain average times for the common elements and all incidental delays. It is often necessary to give considerably more time to determine allowances for delays than the common elemental times because of infrequent occurrence. Special effort should be made during the study to record every detail of information concerning the operation, regardless of how trivial it may seem at the time, because it may be a necessary link to an important decision. The omission of one fact may mean repeating a complete study, requiring hours.

When all the necessary information has been gathered, the next step is the study analysis. The importance of this part of the development is obvious. Here is a mass of details from which orderly standards are developed. Averages must be selected for the common elements and percentages obtained for incidental delays. First, the study sheets are figured to obtain net times from watch readings, and after casting out unusual times a total is taken and averages computed. These sheets are then separated into groups according to operation differences and stock classification, and recorded horizontally on long sheets of columnar paper where weighted averages by groups are obtained and percentages are figured for various stock delays against total actual running time. From this sheet, comparisons are made and normal times determined.

The next part to consider is the composition or assembly of the selected time averages and allowance percentages taken from the study analysis sheet. This consists of recording all the essential information concerning the operation, including normal payroll, machine speeds, handling elements, detail of incidental delays, and the final computation of the standard by products. The prepared

sheets are then typed and kept in a loose-leaf binder with tabulated divisions indicating operations. In this form the information may be easily supplemented or conveniently used. Form 5 is an example of the recorded form, simplified for illustration, containing hypothetical figures of a paper waxing or coating operation.

Checking up should not be construed as being the proof to the standard, as the term may indicate, but should be considered as a measure of the efficiency of past performance. This is determined by applying the standard against the production of two or more normal months and comparing the man hours to the actual payroll hours. The percentage obtained by dividing the actual time difference by the standard time allowed indicates the marginal allowance from which the bonus allowance is made. This bonus allowance when definitely set is then added back to the total standard time allowed and the difference between this bonus allowance and the actual hours is divided by the actual time to obtain percentage saved before bonus operates. It is not unusual for the saving to be sometimes as much as 33 1/3% and for the operation to appear ordinarily efficient.

Paper Waxing Department

Normal Crew			Hours	
No.	Men		Daily	
8	operators		72.00	
Indirect 1	foreman	9.00		
1	trucker	9.00	18.00	25% of operating
			90.00	

Foreman's time, which is 11.11% of 81.00 hours normal working payroll, is adjusted at end of week according to actual working payroll to make an additional allowance if less than normal or a deduction if greater than normal.

Handling Elements	Minutes
Replace Roll	5.25
Threading	2.15
Remove Roll	3.80
Time Per Cycle	11.20

These elements are combinations of subdivisions recorded on the study sheets grouped in this form for convenience.

Incidental Delays	Tissue	Bond	Manila
Stock Allowances:			
Paper Breaks	4.25	2.10	1.00
Test Samples	2.15	2.15	2.15
Stock Adjustments	.50	.50	.50
Miscellaneous	2.00	2.00	2.00
(Recording Prod.—Etc.)			
Average Time Per Roll	8.90′	6.75′	5.65′
Running Time Per Roll	50.00′	33.33′	13.33′
Percentage of Running Time	17.8%	20.3%	42.4%
General Allowances:			
Machine Preparation 25.00			
Machine Adjustments 5.00			
(Wax Temperature, Etc.)			
Clean Rolls and Scraper 10.00			
Miscellaneous 10.00			
(Helping—Get Supplies —Etc.)			
Daily Allowance Per Man ..... 50.00′			
Divided by (540.00′-50.00′) Equals 10.2% of Working Time			

FORM 5

The stock allowances are obtained from analysis sheet when percentages are calculated from actual running time according to stock classifications. The delays are recorded from study sheets in detail on the analysis sheet and percentage comparisons are made which assist in determining normal conditions.

The general allowances are determined from average times on

study sheets with number of occurrences based on order changes and occasional possibilities in terms of a normal day.

Machine Allowance

Repairs—Speed Variation. 5% of Running Time.

All delays, such as repairing machines, replacing belt on line shaft, and others resulting from mechanical defects, are included in a general machine allowance and not considered in incidental delays on study sheet when recorded.

Human Allowance

According to chart explained previously.

Running Time

Constant factor based on machine speed.

All the enumerated factors, after a thorough analysis, are composed according to stock classifications determined by time or cycle variation. The form is simple and pliable, making it easy to determine special standards without a complete time study by using the common elements of the operation applicable to the special stock. The regular form of recording the composition of the standard is as follows:

Paper Waxing	Tissue	Bond	Manila
Dry Paper Weight Per Ream....	15#	25#	75#
Average Lineal Feet Per Roll....	30000	20000	8000
Running Time (600 F. P. M.)...	50.00	33.33	13.33
Handling Elements	11.20	11.20	11.20
Incidental Delays	16.05	11.98	8.73
	27.25	23.18	19.93
Machine Allowance (5% of Running)	2.50	1.67	.67
Human Allowance	7.88	5.77	2.91
	87.63	63.95	36.84
Totals—25% Indirect Added....	109.54	79.94	46.05
Man Hours Per Roll.....	1.83	1.33	.77
Man Hours Per 1000 L. F.....	.061	.067	.096

Man Hours Per 100 Pounds..... (1000 Sq. Inch Yield—1" Wide)	.508	.558	.800
Bonus Standard (40% Allowance)	.711	.781	1.120

A few explanations might be helpful in quickly understanding the calculations made in the above form. First of all the dry paper is received in rolls of standard specifications from which a theoretical length is calculated. Running time is the obvious division of roll length by the constant machine speed. The handling elements are typical in this example for all stock. Incidental delays are computed by taking Stock Allowance percentages of the running time and adding this to the time for General Allowances obtained by taking the percentage of the Running, Handling and Stock Allowances together. The Machine Allowance, as indicated, is 5% of Running Time. Human Allowance is taken from the chart shown as Form 4 by first calculating the per cent handling time, including incidental allowances, of total working time. Indirect is the allowance for time not directly connected with the operation and is applied on total time allowed. The total time in minutes for each roll is then converted into man hours which is divided by the length per roll to get man hours per 1,000 lineal feet, which is the true production unit.

Next comes the last conversion which establishes the standard in the proper term of application, which is weight. The common unit used in the example is weight of paper yielding 1,000 square inches per pound in rolls one inch wide. The standard ream basis is 480 sheets, 24 x 36, or 414,720 square inches. Therefore, if 15 lb. tissue is waxed to 20 lb. per ream, the finished yield would be 414,720 divided by 20 lb., or 20,736 square inches. A chart of reciprocals made by dividing various yields by possible widths is used to convert the few standards in this common term to the many possible variations. In the example shown the standard is originally in man hours per 1,000 lineal feet, or 12,000 inches. Therefore, to obtain the standard on one-inch width, 1,000 square inch yield, which would be twelve pounds per 1,000 lineal feet, the standard in terms of length is divided by 12 lb. and multipled by 100 lb. In this common term the standards may be applied to stock of any specification of a particular group by multiplying by the yield (in 1,000 square inches) and dividing by the width.

This conversion is important because it reduces the standards required to a minimum and facilitates application.

The principle of this conversion usually can be applied wherever the basic unit of production is other than weight. If the operation is casting metal ingots, the standards are established on the number of ingots produced, converted to the unit of 100 lb. (one square inch of standard thickness) according to composition of metal produced. Before the standards can be applied to weight produced, a division by the actual square inch area must be made. Likewise, the operation of rotary cutting, with a constant speed of cuts, is originally set per 1,000 sheets, which is converted to 100 lb. (1,000 square inch yield—100 square inch area). An operation like flat cutting depends upon time per board which is based on method of cutting and number of cuts made. In this instance standard board weights are determined for the various stocks and time standards, by weight, and calculated by use of reciprocals.

Graphs are used quite often to show standards on regular stock and according to exact specifications, to eliminate the necessary conversion. Logarithmic forms are used where standards per hundred pounds are reduced proportionately as the size increases. The sizes are represented by the vertical lines and the time allowed, by the horizontal lines. The various stocks, according to yield, are plotted in straight lines as shown by Form 5, page 107.

Production from the various operations is recorded on tickets in duplicate with essential information required for determining time allowed. The original ticket is sent to the Bonus Department for credit and the cardboard duplicate is attached to stock for proper identification. Form 6 shows the style of ticket used for all departments.

This article would not be complete without at least the mention of bonus paid for scrap saving. Briefly, this is figured by calculating the loss of scrap compared with labor cost based on time standards. The ratio obtained of scrap loss to payroll is used against percentage of scrap saved in good production. This percentage saved, in terms of payroll, is then halved in accordance with payment plan.

In closing, the writer regrets the necessary brevity in the description of this plan. The hope is, however, that a general picture

INTERDEPARTMENTAL PRODUCTION Dept.____ **No 7916**

Date	**Order No.**
Stock No.	
Oper.	**Size**
No. Units:	**Yardage**
Reels	
Boards	**Gross Wt.**
Spools	**Tare**
	Net Wt.
Deliver To	

F - Form No. 3094 5.18.32 500M sets

FORM 6

has been presented which will stimulate confidence in the reader to attempt similar undertakings of improvement, adaptable to conditions peculiar to his employment. This paper, as it is read by the writer, produces a feeling in contrast to that no doubt experienced by the negro who looked upon the Pacific Ocean for the first time and was told that it was the world's largest body of water. The negro replied, "Yes, suh! So I see."

TIME STUDY AND ITS RELATION TO THE PIECE RATE METHOD OF WAGE PAYMENT

Prepared by the Standard Department of the Trico Products Company, Buffalo, N. Y., under the supervision of C. O. Rainey, Chief Accountant

The piece rate method of wage payment is, we believe, the most universal method of wage incentives used today and because of this fact more abuse or absence of scientific methods of determining such rates are evident.

Standard time, which is the basis on which all proper rates are determined, is just as flexible as any other medium. Indirect workers can be compensated with the same degree of skill as direct workers, if desired.

These instructions are followed by our Standard Department and, as you will find, they go into detail explaining the reason or

motive back of each element. However, they were prepared with the thought of making it as easy as possible for the average time-study man or accountant to understand.

The Time and Motion Study

The primary object in taking a time study of a shop operation is to arrive at a standard time: i.e., a standard rate of production. This standard of production, when established, may be used as a basis for any of the following:

(a) Payment of a bonus as a reward for efficient production.
(b) Establishing a piece rate for the operation.
(c) A check on present or proposed shop methods.
(d) A system of production control.
(e) An accurate labor cost.
(f) A check on the efficiency of the workers.
(g) To stimulate the worker to greater effort and to reward him in proportion to that effort.

Standard time may be defined as the time required to perform a given operation or group of operations by the average competent workman repeatedly over an extended period without undue effort, with all waste motion eliminated, and producing the required quality of product. Allowance is made in the standard time for minor delays incident to shop conditions and for the personal necessities of life.

Time study and analysis may be divided into two classes:

(a) That study and analysis which is made for the purpose of finding out what is wrong with a process of operation as is exists.
(b) That study which is made after existing conditions have been standardized and the one best method or sequence has been established.

The first of these classes is "motion study," and its primary object is to discover delays, false or unnecessary motions and their causes, and defective operation sequences. The second of these classes is "time study" which is the study of the required time of the cycle of motions.

It is necessary that time study observations be taken carefully by an experienced time study observer, or one who is working under the immediate direction of such a man. The securing of

accurate elementary times is something more than merely timing the best workers and from this time determining a base time or piece work rate for the performance of the work. Consideration must be given to:

(a) The worker and his productive ability.
(b) The conditions surrounding the operations.
(c) The method of performing the operation.
(d) The effort of the worker.
(e) The fatigue factors necessary.
(f) The desired quality of product.

The worker must know full well that he is being studied. It must never be done secretly; otherwise his full cooperation cannot be had and, worst of all, he will lose confidence in the square dealing of his employer.

The stop watch should not be looked upon as the instrument by which the time to perform an operation is determined but only as a guide to aid in the proper analysis of the job and the determination of the standard time. The time study man must first standardize the conditions and the method surrounding an operation and then he must give careful consideration to the operator's effort and the fatigue factors. The time study man's judgment plays by far the largest factor in the determination of the standard time and the stop watch serves only as a guide.

Standard Worker

A standard worker on an operation is that worker who meets the requirements of the operation as to skill, experience, strength, stamina, carefulness, and provides the standard quality of work at the least cost. The standard time or piece rate on an operation is based on the performance of the average standard worker on that operation regardless of what class of worker was performing the operation during the study.

If the worker on the operation during the study is of higher class than the average standard worker, and because of this is producing more than can be procured from the average standard worker, the time study man must take this into consideration in determining the time. The same procedure applies if the worker happens to be of a lower class than the average standard worker

and is producing less than can be procured from the average standard worker.

Standardization of Conditions of an Operation

Conditions of an operation are the states, positions, qualities, properties, and attributes of all physical things which affect the performance of the operation.

The principal conditions of an operation consist of:

A. Surroundings—Air, lift, temperature, fumes, dirt, dust and floor.

B. Mechanical equipment—The kind, state, position, safety, speed, and adjustment, of machine, tools, fixtures, dies jigs, etc.

C. Article being worked on—The kind, size, gauge, and quality of material.
The location of the article before and after the operation.
The part number, name, and size of articles.
The nature of succeeding operations.

D. Containers—The kind, size, state of repair, and location of all boxes, or pans used as containers.

One of the principal benefits that should be derived from time studies is the discovery of possible operating improvements. The time study man's imagination and initiative should be exercised to the limit on every operation he studies, in order to devise every possible improvement of conditions. As many of these changes as possible should be made before the time study is actually started, in order that time may be taken under as nearly normal conditions as can be secured.

The following discussion of conditions is taken from an article entitled "Foreman Built to Order," which appeared in the "Factory" magazine of March 15, 1920:

> Study the machine itself—make, year made. Is it up to the present standards? Is it equal to present requirements? If not, in what way, and to what extent? If a new machine is called for, or changes involve considerable expense, show how soon such would pay for themselves. Give the safety appliances, sizes of pulleys, belts,

drives, speed and number of units of production per hour as machine is now operated. What does the receipt and delivery of material, and sequence in routing bear to its successful operation? How is the machine operated? Consider the operator size, weight, temperament, experience, nationality, and his adaptability to the job. Does he sit or stand at the work? If he sits, is the seat of right height, size and construction? Is the work exhausting? If so, what provision is made for rest periods? If the operation is hand work, consider the work bench, its dimension, slope, or "tilt," height, as to that of workman. Is it suitable to the job? Describe the tools—are they made especially for the work, or selected from standard makes and adapted to a forced use because there is nothing else Are they too heavy or clumsy? Do they fit the hand? While in use are they dropped upon the bench "hit or miss" to be fumbled for when again needed, or placed in a rack?

Is the light ample? Is any part of the work in shadow at any time? Is it so strong as to affect the eyes? Does the operator wear goggles to protect eyes from dust or flying particles? Concerning the progress of work—are material and supplies delivered to the operator, or does he have to go for them or wait for them? If work is delayed for any cause, give actual time involved, production list, and also how much over a given period.

The time study man during the course of a study may wish to change conditions or method of the operation. If so, he should go to the foreman and have him instruct the operator and not request the operator to do anything unless given permission by the foreman.

Conditions may be standardized by perfecting them in their present form or by changing them completely.

The man writing on a piece of paper with a pencil may increase his production from a few words up to, perhaps, 40 words a minute. He would do this largely by putting himself in the most favorable physical and mental condition and by standardizing his environment, that is his

light, writing surface, seat, paper pencil, the temperature and ventilation of the room. After making all these conditions 100% and improving his method until it is 100% and bringing his efficiency of effort up to normal, 40 words a minute may be the very best he can do. But if he substitutes a typewriter he may with comparative ease, be able to increase his production from 40 words a minute to 80. He would have changed his condition entirely. Then if he discarded the typewriter and dictated to a stenographer he may increase from 80 to 125 words a minute. Again he would have changed his conditions entirely.

What we want is not the best, easiest and quickest way of doing things, but the best, easiest and quickest way of obtaining the *most desirable results.*

The existing conditions under which an operation is being performed will affect the production that will be secured by an average standard worker. If the existing conditions are not the usual or normal conditions the time study man must measure the production that can be secured by the average standard worker under the normal conditions and determine the standard time to perform the operation under normal conditions. It may be desirable at times to set a temporary standard for existing conditions.

Standardization of Method of an Operation

The method of a given operation is the procedure, mode, manner and sequence of performing said operation. The standard method is that which has been determined by the time study supervisor, both as to the worker's motions and the sequence thereof, as best fitted to attain the desired result with least effort and expenditure of time.

There is a distinction between conditions and method in an operation. The conditions are the material things surrounding that operation while the method is the motions executed by the worker in performing the operation.

Conditions and methods in actual practice are inseparable. Almost every change of condition requires a change of method, and many changes of method require changes of conditions.

The chief value of time studies lies in the standardization of conditions and of methods made possible by them. There can be but one best, easiest, and quickest way for doing anything. It is the problem of the time study man to find this way. The method he shall follow in arriving at his decisions is a matter of training, experience, and good judgment. Imagination is necessary. Initiative is essential. He must be careful not to abandon tried methods for untried ones, when the first are best; nor on the other hand should he stick to old methods when better ones can be devised.

Answering these questions will help to standardize the method of operations:

(a) Are there any lost motions, or motions too long in duration, in removing and placing the work aside when the operation is completed?
(b) Is the work done spasmodically or with smoothness?
(c) Are there any awkward motions?
(d) Does the worker go through the same sequence of motion for each cycle?
(e) Are there any unnecessary motions in the cycle?
(f) Can the work be so arranged that right and left hand motions can be performed at the same time?
(g) What will be the best motions and the best sequence for the standard cycle?

Effort

The effort of a worker in doing an operation is the exertion or application of mental or physical power. The normal effort of an average standard worker in doing an operation is the maximum effort which he can expend throughout each normal working day without hastening the normal decrease of vitality ordinarily suffered with increasing years.

The efficiency of effort of a worker in doing an operation is the ratio of the production that would be secured by an average standard worker, exerting normal effort and using the standard method under normal conditions, to the actual production of the worker from his actual effort and using the standard method under normal conditions. Hence a rating on "Efficiency of Effort" is not a rating of the actual energy thrown into the work but of

the accomplishment therefrom, as compared to the standard accomplishment.

Workers generally fall within one of these groups:

(a) Experienced, capable and efficient while being studied, thus earning a high effort rating.

(b) Experienced and capable but because of nervousness, unintentionally not efficient while being studied, thus earning a low effort rating.

(c) Experienced and capable but because of nervousness while being studied speeds up above normal, thus earning a high effort rating.

(d) Intentionally injects waste motions, thus earning a low effort rating.

(e) Generally mediocre, injects unnecessary motions and slow.

Sample Time Study

Accompanying these instructions is a sample time study, Figure 1, taken from the study on file of "Grease Buff & Color" Mirror Support Bracket.

The upper part of the form above the section headed "Preliminary Remarks" is self-explanatory. The section for preliminary remarks is to be filled in with statements describing the general picture of the operation, such as: how the machine is operated whether by foot trip or Benjamin handles; the safety features, how the material is located and handled, etc. In the study mentioned here, the speed of the wheel, time of day and condition of the metal are noted.

The operation studied was divided into seven elements (excluding wheel change) and readings were taken for ten pieces in each element. It will be seen by the last reading of element No. 7 that the study consumed 29.6 minutes. The lower figure in each element is the number of minutes elapsed since the study was started, and the upper figure is the number of minutes elapsed since the previous reading is shown and designates the time it took to perform the particular element or operation.

The average time taken for each piece in each element is shown in the second to last column, and the standard time allowed each

Fig. 1

TIME STUDY ANALYSIS

Form 74

Date 12/10/31 | Dept. 12 | Part Name Bracket (Mirror Support) | Part No. 2642-C

Emp. No. 12133 | Day Rate | Operation Grease, Buff & Color | Oper. No. 6 | Bur. No. 1201

Mach. No. | Tool No. | Material .031 1/4 Hard Brass | Study No. 4356

Preliminary Remarks 2400 R.P.M. 9:25 A.M. Brass A-1 Slightly Die Marked-Code

Minutes per 1 Piece by Element 90-96%

	Actual Elements	1	2	3	4	5	6	7	8	9	10	Minutes per piece Average	Minutes per piece Std.
		14" x 3" Sheepskin 200 Emery											
	Grease All		.29	.26	.28	.31	.27	.31	.28	.29	.27		
1	Edges	.5	.52	.56	1.12	1.44	1.71	2.02	2.3	2.58	2.86	.286	.286
		Bevel											
	Wheel Change	12" x 1-1/2" Sheepskin 200 Emery									.93		
											3.79		
		Cop only											
	Grease "Flat"	not here											
2	& into corner	.22	.22	.22	.24	.26	.26	.21	.18	.21	.22		
		4.01	4.26	4.5	4.74	4.97	5.23	5.44	5.62	5.83	6.05	.226	.226
		14" x 1" sewed cotton buff									.56		
	Wheel Change										6.5		
		x	x	x	x	x	x	x	x	x	x		
	Buff Edges &	.41	.5	.46	.52	.58	.46	.5	.44	.46	.41		
3	across Ends	7.01	7.51	7.97	8.49	9.07	9.55	10.05	10.49	10.94	11.35	.475	.45
		x	x	x	x	x	x	x	x	x			
	Buff Back	.33	.38	.42	.37	.35	.39	.33	.3	.36	.4		
4		11.68	12.06	12.48	12.85	13.2	13.59	13.92	14.22	14.58	14.98	.363	.35
		x	x	x	x	x	x						
	Buff Base	.28	.25	.3	.3	.34	.35	.30	.31	.31	.31		
5		15.23	15.48	15.78	16.08	16.42	16.77	17.07	17.38	17.69	18.00	.302	.302
		12" x 1" bevel sewed cotton buff									.56		
	Wheel Change										18.56		
	Buff into corner												
	& over inside	.57	.63	.48	.54	.47	.51	.5	.5	.5	.53		
6	Back	19.13	19.74	20.24	20.78	21.26	21.82	22.32	22.82	23.32	23.85	.529	.5
	Wheel Change	6" x 1-1/2" loose cotton									12.46		
		.42	.41	.44	.4	.5	.4	.42	.39	.46	.41		
7	Color Complete	26.87	26.28	26.72	27.12	27.62	28.02	28.44	28.83	29.19	29.6	.395	.395

Symbols Apply Tripoli to Wheel

TOTALS	2.576	2.508
Plus Personal Allowance	5 %	.20
Extra Allowance Wheel Care	3 %	
Minutes Allowed One Piece	call 2.727	
Minutes Allowed 100 Pieces		272.7
Prod. per Hour 22		
Std. Time Hr. 100 Pieces 4.54	Prod. 9 Hrs.	

Signed F.C.L.

Approved O.P.F.

Base Rate $.80 Per Hour Price per 100 pieces $3.63

FIGURE 1

piece in each element is shown in the last column. This standard time is purely a result of judgment of the time study man as the time required to perform that element over an extended period without undue effort and with all waste motions eliminated. The advantages in breaking up an operation into its elements are many

and cannot all be set down here. It enables the time study man to eliminate wasted effort and motion a lot better than if he took an over-all study of the ten pieces in 29.6 minutes. It also shows him the time required to perform each element and gives him an idea of the fatigue factor of the job. If some particular element in the study is discontinued or has changes made in it which will effect the time, study will not have to be made of the entire operation but only of the particular element involved.

In addition to the time allowed in each element, time is also given to properly recover and take care of the grease wheels used in the operation.

Personal allowance is the time allowed for going to the lavatory, getting drinking water, receiving instruction, changing time tickets, etc. This personal allowance is added on each operation and is shown in the time study as an additional allowance. It varies for men and women. The allowance for women operators is usually 10% and for men it varies from 5% to 8% depending upon the department and the work.

The total standard time is changed from minutes to hours for the benefit of production planning. The base rate for the class of work in which the operation falls is shown and the price per 100 pieces is obtained by multiplying the base rate by the standard time hours per 100 pieces.

A time study can be taken on any operator who is accustomed to the operation, whether he be fast or slow. The time study man makes careful study of the operator's effort during the study as well as the method he uses. If in the time study man's judgment the operator is working faster than the average worker would do on that operation over an extended period, he allows more time than the operator is taking. If in his judgment the operator is using unnecessary motions or is working slower than the average worker will on that operation over an extended period, he allows less time than the operator is taking. Just how much more or less time should be allowed is entirely a matter of his judgment and experience.

The opposite side of the time study form gives additional remarks about the "Conditions" surrounding the operation and the standard method of performing each element of the operation.

Also, if there is a rate change, the old rate, old study number, and reasons for change are given.

Particular attention must be given by the time study man to the required quality of the operation and his standard time allowance must enable the operator to produce the required quality and still make piece work pay.

Each time study is numbered and the number appears upon the rate card to properly identify the rate with the time study. The time studies are filed by their numbers.

Mr. C. E. Knoepell, well-known industrial engineer says: "Many wonder how long a study should take. This is a difficult question to answer. When starting a study it is next to impossible to determine just what will be unearthed in the way of data and facts. A study may take an hour or it may take a week. It all depends upon the work studied, the degrees of complication, and where the strings lead to. A safe rule to follow is: 'Take as much time as will result in sufficient facts on which to base conclusions which will withstand any attacks.' "

Labor Classifications and Base Rates

The standard time in which to perform an operation as shown by the time study is the time it ought to take to perform the operation without undue effort and with every waste eliminated. This time is put in terms of money in the piece rate system by multiplying by an hourly base rate which is predetermined by the management as sufficient both as an incentive and a reward for performing the operation in the standard time.

This base rate, therefore, is the hourly rate the operator will earn when performing the operation in the standard time and is known as the 100% efficiency hourly rate. These base rates are determined for each class of work in the plant.

In each time study the standard time arrived at is expressed in hours per 100 pcs. and the piece rate is determined by multiplying by the piece work base rate for the class of work on which the study was taken.

Request for Time Study

The request for time study must be made by the foreman of the department in which the operation is running. He may, of

course, request that the timekeeper take care of this matter for him. A 'phone call has been found to be the simplest and most efficient means of communication as it is made directly to the time study supervisor.

When a request is received it is immediately checked with the operation sheet in the time study department. If materials, machinery and other conditions reported check satisfactorily with the sheet, an observer is sent to the department to study the operation. Any changes he may make in the operation must have the approval of the foreman.

No request for time study for rate purposes will be honored unless the operation is called for on the operation sheet, except where a temporary condition arises or where the foreman is not entirely satisfied with the present rate. The "temporary condition" is carefully checked with the engineering department, or person responsible for it. If found satisfactory a study is made and a temporary rate is set with a time limit, which may be extended by the time study supervisor only. If a time study is requested because of dissatisfaction with the rate, a new study will be taken but the old rate automatically becomes void. Requests for study of new methods will be honored at all times except where the time study department has suitable information on file.

Operation—Rate Reference Card

An Operation-Rate Reference card, Figure 2, is made out for each time study and filed according to operation. The front of the card shows a simplified sketch of the operation performed, part studied, department the operation was performed in, male or female operator, hourly base rate, burden number, time study number, standard time hour per hundred pieces, pieces required per hour to earn base rate, and rate per hundred pieces. A description of the operation and operating peculiarities is listed at the bottom. The front of the card is really a condensed copy of the time study.

Space is provided on the rear of the card for a record of similar operations on which the rate and method has been used. The date referred, part number, and necessary remarks each has its column. A performance record is also kept at the right. At

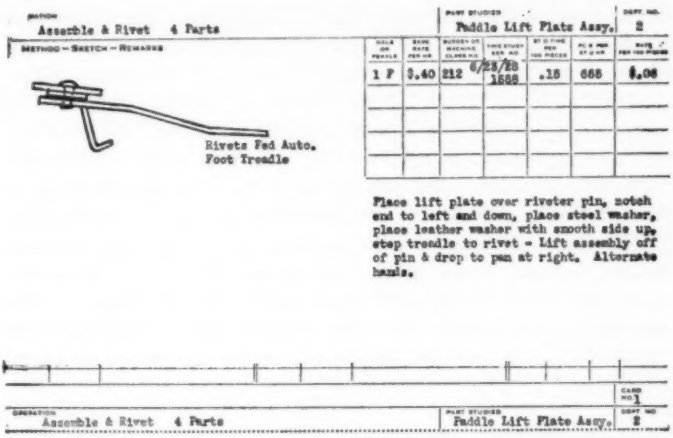


FIGURE 2

various times the efficiency rating of an operator or group of operators, working on any part listed in the reference column, is noted as follows: date of performance, part number, length of the run in hours and the average hourly efficiency rating for that period. The required information on each operation and operator is given to the time study supervisor daily, by the tabulating department immediately after the time cards have been run. The standard hours (hours allowed) to perform the operation divided by the hours taken, results in the hourly efficiency rating.

The Operation-Rate Reference Card is folded at the creased center, and as stated before, is filed according to operation in a visible system for future reference. If it is found advisable to move a part from one card to another due to a method change, a notation should be made in the remarks column, opposite the part number entry, on the old and new card. On the old card the name of the new operation will appear while on the new card the old operation will be listed. Both will be followed by date and "From" or "To" as the case may be.

Any change in method voids the old rate automatically.

As the engineering department issues an operation sheet to each of the interested departments, the original layout is submitted

to the time study supervisor for his approval. The operations are checked with the operation-rate reference file, and the necessary rate and standard time information is noted in its proper place, opposite each operation. Where there is nothing available or where there is a question, the space is left blank until the information can be obtained by a time study. As soon as all available information has been noted, the layout is O. K'd. and returned to the engineering department for immediate typing and distribution.

The Operation-Rate Reference Card serves one very valuable service, at least, in that if one part is transferred to a more efficient method, all similar parts listed should also be changed. The performance record is also very valuable, for if operators can "make their rate" on one part it should be possible to do so on all others.

Rate Distribution

Whenever a new operation layout is issued by the engineering department, the original is sent to the time study department for the approval of the time study supervisor. At this time the operations are scanned, and wherever possible, the number of operators required (male or female), time study number, standard time hour per hundred pieces, production required per hour to earn the base rate and the rate per hundred pieces are noted in their proper places. If some of the operations are not covered by any information in the files, arrangements are made for studies as soon as practical. The sheet is not held up but is O. K.'d. and returned to the engineering department where it is re-typed, the necessary number of copies "dittoed," and distributed to all interested departments.

When a time study has been taken on an operation and the rate, etc., has been set, a Rate Change Notice, Figure 3, is filled out and sent to the engineering department. The correction or addition of the rate is then taken care of by a new issue of the operation sheet. A duplicate of the rate change notice is immediately delivered to the timekeeper in the department affected. This is filed in his book just ahead of the regular sheet and is his authority for the immediate use of the rate. It is destroyed as soon as the new issue reaches him.

Form 705 Fig. 48

RATE CHANGE NOTICE PART NO

OPERATION	Dept. No.	No. of Operators Male	No. of Operators Fem.	Machine or Machine Class No.	Dia or Tool No.	Time Study Ser. No.	Std Time per 100 pieces	Pieces per Std Hour	Piece Work Rate per 100 Pieces

APPROVED BY ..... TIME STUDY DEPT.

DATE 19

FIGURE 3

All rate corrections, etc., are noted on the operation sheet in the time study department as an added precaution, until the new issue is received and filed.

Piece Work Time Tickets for Day Rate

All time tickets for operations on which there is a piece rate and which, through no fault of the operator, are to be paid day rate, are first to be O. K'd. by the foreman and then by the time study supervisor before being submitted to the payroll department. The reason for such action is noted on the card by the timekeeper before signatures are requested.

In the case of O. K. for a day rate made necessary by a change in method, the piece rate automatically voids itself and a new study should be requested as soon as practical. If the time study supervisor does not approve the payment of day rate and desires to change the day rate statement to piece work, he should advise the foreman of the reason for his decision. In this manner many operating defects have been corrected that would otherwise get by unnoticed for a time, at least.

Piece Work Data

The tabulating department submits a daily report on each department to the time study supervisor. The report is dated and information is listed across from left to right, as below:

Part No.	Oper-ation No.	Burden No.	Oper-ator's No.	Hours Allw.	Hours Taken

Every piece work operation that makes up the worker's time is listed under his or her number and in the order performed.

The hours allowed divided by the hours taken results in the efficiency rating for each operation. From this report a departmental sheet is set up showing the ratings for each department as follows:

Average rating of all operators below standard.

Average rating of all operators above standard.

Average rating of all operators.

The last item is the departmental piece work efficiency rating. Copies of the departmental sheet are sent to the foreman, superintendent and office manager on the day following performance of the operations.

The foreman is also given a daily report of each operator below standard, listing the operations and rating of each.

The above reports often bring to light unfair conditions affecting operator and employer which would otherwise go uncorrected, possibly creating a feeling of resentment on the part of the operator over some grievance which was caused quite unintentionally.

Changes of Piece Rates

It will be of enormous advantage to us in stabilizing our wage incentive system if we never have to change a rate on file for reasons other than changes of conditions or method in performing the operation. This condition should be our goal, our object. It will mean more satisfied labor and will repay itself many times in goodwill to the management.

It must be thoroughly understood that all changes of equipment or method in performing an operation on which a piece rate is set must at once be reported to the time study supervisor whether such changes slow up or speed the operation. Whether the piece rate is to be changed or not must be left to the time study supervisor only, and he must, therefore, be notified promptly so he can study the new arrangement. See instructions under "Request for Time Study."

A piece rate on an operation shall be increased:

(a) To correct a mathematical error in computation.

(b) To correct error of observation if a subsequent time study and investigation show that the correct time should be ten per cent or more greater than the standard piece rate on the operation.

(c) When standard conditions are changed or when standard method is changed so as obviously to slow up an operation.

In all cases, however, the circumstances must be taken into consideration before the final decision.

A piece rate on an operation shall be reduced:

(a) To correct a mathematical error in computation.

(b) To correct a gross error of observation if subsequent time study and investigation shows that the correct time should be at least twenty per cent less than the standard time and piece rate on the operation.

(c) When standard conditions are changed or when standard method is changed so as obviously to permit a shorter time to perform the operation.

The circumstances in each case shall decide.

Rate Change Notice

The rate change notice, Figure 3, is issued by the time study department when a correction, addition, or cancellation of a rate or group of rates has been found necessary after the operation sheets have been delivered to the departments interested.

The rate change notice shows the part number, operation affected, department number, male or female operator, burden or machine classification number, die or tool number, time study number, standard time per 100 pieces, pieces per hour to earn base rate, and the rate per 100 pieces.

The rate change notice, after being filled out as above, is O. K'd. dated by the person in the time study department issuing the information and sent to the engineering department. A copy is also sent to the timekeeper in the department affected.

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